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(54) Liquid crystal display device and method of fabricating the same

(57) A liquid crystal display device comprises first and second substrates 1 and 2 disposed at a predetermined gap d1; a liquid crystal sealed in the gap d1; a seal member 4 provided at the gap d1 between the first and second substrates 1 and 2 and outside a display area 3, the seal member 4 being for sealing the liquid crystal; and a wall-like structure 5 provided outside the

display area 3 and inside the seal member 4, the wall-like structure 5 being made of a material different from that of the seal member 4 and composed of a plurality of rows, effective to prevent flow of the seal material into the display area.

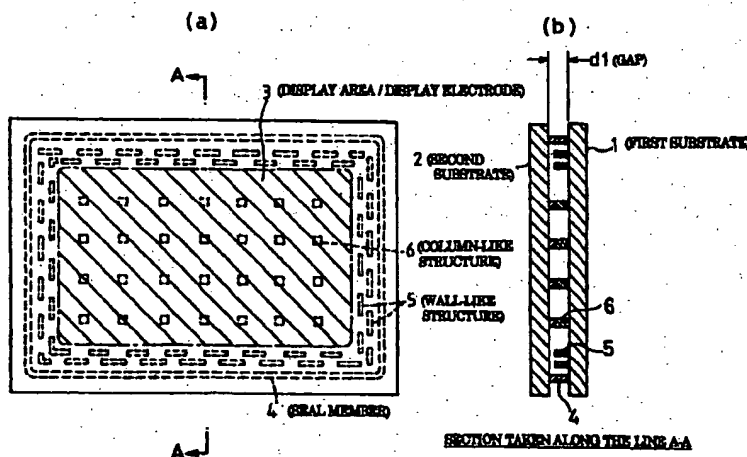


FIG. 1

Description

Technical Field of the Invention

[0001] The present invention relates to a liquid crystal display device, more particularly to a liquid crystal display device which provides a seal member for sealing periphery portions of two substrates, and a method of fabricating the same.

Background of Invention

[0002] An active matrix liquid crystal display device which uses a thin film transistor, comprises a TFT array substrate in which gate electrodes (Y-electrode) and data electrodes (X-electrode) are arranged in the form of a matrix and thin film transistors (TFT) are disposed at intersecting points of the matrix, and an opposite substrate located so as to face the TFT array substrate with a gap therebetween. By means of the thin film transistors, the display device controls a voltage applied to a liquid crystal which is sealed between the TFT array substrate and the opposite substrate, so as to display an image by utilising the electro-optic effect of the liquid crystal.

[0003] A seal member has been generally employed to seal a liquid crystal between two substrates made of glass or the like, which serves to guard the liquid crystal from contamination due to water from the outside of the device and other environmental changes. This seal member is made of thermoset resin and ultraviolet-curing resin, and is formed on a periphery portion of one of the two substrates, using a painting method by means of screen printing or a dispenser. The other substrate is adhered to one substrate on which the seal member is formed, and then both substrates are pressed to each other while heating them. In the case of the ultraviolet-curing resin, the resin is cured. Thus, both substrates are joined by the seal member. Properties showing low curing temperature and freedom from contamination for the liquid crystal by the curing agent, besides a high mechanical adhesion strength and a high stability for environmental changes in temperature and humidity, are required for the seal member.

[0004] Background art concerning the seal member, technologies for constituting the seal member to a double structure is disclosed in the following gazettes: For example, in Japanese Patent Laid-Open No. Sho 57(1982)-171319, notches are provided in an inner seal member of the double structure, whereby a seal width contributing to a gap regulation is made to be large. In Japanese Patent Laid-Open No. Hei 5(1993)-5890, a corner portion of an inner seal member is broken, whereby air traps, which are hollow portions created by entering of air to a place to be originally filled with the liquid crystal, is made not to be produced in the liquid crystal in injecting the liquid crystal into the double

structure. Moreover, in Japanese Patent Laid-Open No. Hei 5(1993)-127177, a plurality of openings are provided in an inner seal member, whereby the liquid crystal is injected into the double structure in a short time without damaging an alignment film. In Japanese Patent Laid-Open No. Sho 64(1989)-54420, an opening portion is provided in an inner seal member, whereby a sufficient amount of a liquid crystal can be injected into an area of the inner seal member.

[0005] Furthermore, in Japanese Patent Laid-Open No. Hei 5(1993)-232482, a wall portion made of a metal wiring material is formed in a liquid crystal injection port of a single circular seal member so as to make a flow direction of the liquid crystal unchanged, thus preventing an occurrence of alignment disorderedness and defect of alignment.

[0006] Although the following technology does not directly relate to the present invention, a technology, in which an outer periphery for connecting a reflection plate and a liquid crystal cell is buried with a seal member and double projections are provided inside of the seal member, is disclosed in Japanese Patent Laid-Open No. Sho 62(1987)-286018.

[0007] As described above, there are many background articles concerning seal members. All of these background technologies can be adopted so that an area that is a periphery of the display area in the liquid crystal display device can be sufficiently secured. However, owing to a demand for miniaturisation of the liquid crystal display device in recent years, a frame area around the display area, which is as narrow as 2 to 3 mm, must be employed. The two substrates are pressurised and heated after the two substrates are laid on top of another, so that the seal member flows out partially in a fluidized state. In the case of the narrow frame, the seal member sometimes spreads into the display area via wirings. Particularly, since mixed resin is used for the seal member, the flowing-out speed of the seal member differs depending on a difference in materials, and the spread of the seal member is not straight. As a result, since the seal member spreads out in a melted state while producing meanders, an area that projects significantly from the frame partially occurs. The display area in the liquid crystal display device is constituted so that the liquid crystal is ordered by an alignment film so as to be arranged correctly. If the seal member spreads into the alignment film, a thin film made of the seal member is, for example, formed on the surface of the alignment film, and the alignment of the liquid crystal is disordered. Furthermore, in the case of a normally-white mode in which upon application of a voltage, a displayed image becomes black, the portion of the display area where the seal member spread remains white in spite of the application of the voltage. Hence, there is a problem that a defective display occurs.

Disclosure of the Invention

[0008] The present invention solves such problems, and the object of the present invention is to provide a liquid crystal display device which is capable of preventing a seal member when melted, from flowing out into a display area.

[0009] Another object of the present invention is to provide a liquid crystal display device which is capable of preventing a defective display owing to generation of air traps in injecting a liquid crystal into a gap between superposed substrates.

[0010] Still another object of the present invention is to provide a liquid crystal display device which is capable of preventing a cell gap from varying differentially between super-posed substrates.

[0011] Accordingly the invention provides a liquid crystal display device which has a first substrate and a second substrate disposed with a predetermined gap between them; a seal member provided in said gap between said first and second substrates, said seal member being disposed outside a display area to seal a liquid crystal material in said gap; and a barrier structure disposed outside said display area and inside said seal member, said barrier structure being effective to prevent said seal member from flowing into said display area without preventing flow of said liquid crystal material.

[0012] According to another aspect, the invention provides a method of fabricating a liquid crystal display device, comprising the steps of: applying resin onto a first substrate, and patterning said resin to form a frame-shaped barrier structure surrounding a display electrode area; applying a frame-shaped seal member outside said barrier structure; arranging a second substrate so as to face said first substrate on which said seal member is applied, and pressing said second substrate to said first substrate, thereby adhering said first and second substrates to each other by said seal material; and injecting a liquid crystal material into a gap between said first and second substrates, which are adhered to each other, said barrier being formed so as to prevent flow of said seal material into said display electrode area without preventing flow of said liquid crystal material during said injection step.

Brief Description of the Drawings

[0013] The invention will now be described, by way of example only, with reference to the accompanying drawings, in which;

Figs. 1(a) and 1(b) are views of a generalised liquid crystal display device according to the present invention;

Fig. 2 is a perspective view of substrates forming part of a liquid crystal display device according to

the present invention, prior to assembly;

Fig. 3 is a plan view showing greater detail of the array substrate of Figure 2;

Figs. 4(a) and 4(b) are partially sectional views of different constructions of a liquid crystal display device according to the present invention;

Fig. 5 illustrates the effect of joining both the substrates of Figure 2; and

Figs. 6(a) to 6(e) illustrate the fabrication of a liquid crystal display device according to the present invention.

Detailed Description of the Invention

[0014] As shown in Figs. 1(a) and 1(b), a liquid crystal display device of the present invention comprises a first substrate 1 and a second substrate 2, which are disposed at a predetermined gap d1; a liquid crystal sealed in the gap d1; a seal member 4 provided at the gap d1 between the first and second substrates 1 and 2 and outside a display area 3, the seal member 4 being for sealing the liquid crystal; and a barrier structure 5 provided outside the display area 3 and inside the seal member 4, the barrier structure 5 being made of a material different from that of the seal member 4 and composed of two walls.

[0015] If the barrier structure 5 is composed of two or a plurality of walls (illustrated as dashed lines), each of which consists of alternate wall portions separated by predetermined notches, the liquid crystal can be injected into the gap d1 fully without producing air traps in injecting the liquid crystal into the gap d1. Thus, image quality can be improved. It should be noted that the length of the notch of the dashed row need not necessarily be constant.

[0016] Furthermore, if the walls of the barrier structure 5 are offset (staggered) along their length so that the notches do not align, the seal member 4 does not flow out directly into the display area 3 when it melts, thus preventing the manufacture of a defective display. The staggered formation of the notches of the plurality of rows ensures that the plurality of rows of the wall-like structure 5 forms a barrier in front of the display area 3 when viewing from the seal member 4.

[0017] Furthermore, from the viewpoint of preventing the flowing-out of the seal member 4 and from the viewpoint of designing the narrow frame, the number of the plurality of rows should be set to about two to three.

[0018] In addition, if a column-like structure 6 for keeping the gap d1 between the first and second substrates 1 and 2 constant is provided, and the shape of the wall-like structure 5 is determined based on the state of the column-like structure 6, the gap in the periphery portion having the wall-like structure 5 is not

different from that of other portions. Thus, also in this point, the occurrence of a defective display can be prevented. To be more specific, an area (area for the opposite substrate) of the column-like structure 6 per a unit area (predetermined area) and an area (area for the opposite substrate) of the column-like structure 6 including the wall-like structure 5 are substantially set to be constant. With such structure, it can be prevented that the gap is larger by the wall-like structure 5, thus preventing the gap d1 from being disordered.

[0019] The notches of the dashed row in the wall-like structure 5 are determined based on positions of wirings formed either on the first substrate 1 or on the second substrate 2. Thus, it can be prevented that the seal member 4 melts and reaches the display area 3 via the wiring.

[0020] Furthermore, if the wall-like structure 5 is constructed so that the height of the wall-like structure 5 is smaller than the gap d1 between the first and second substrates 1 and 2, though the seal member 4 partially reaches the gap of the wall-like structure 5, the seal member 4 is prevented from reaching the display area 3. In other words, by actually widening the gap of the wall-like structure 5 by capillary phenomenon, the flowing-out of the seal member 4 can be stopped at the portion of the wall-like structure 5.

[0021] Here, the wall-like structure 5 in the present invention may be provided in any of the first and second substrates 1 and 2. However, if the wall-like structure 5 is provided in a substrate in which the column-like structure 6 is formed, the wall-like structure 5 can be formed in the same patterning step as that for forming the column-like structure 6.

[0022] Furthermore, the liquid crystal display device of the present invention comprises first and second substrates 1 and 2 disposed at a predetermined gap d1, a liquid crystal sealed in the gap d1, a seal member 4 provided at the gap d1 between the first substrate 1 and the second substrate 2, the seal member 4 being disposed outside a display area 3 to seal the liquid crystal in the gap d1, and a wall-like structure 5 disposed outside the display area 3 and inside the seal member 4, the wall-like structure 5 being for preventing the seal member 4 from flowing into the display area 3.

[0023] The seal member 4 flows out in a fluidized state in pressing the second substrate 2 against the first substrates 1 while heating them. The wall-like structure 5 is capable of obstructing the invasion of the melted seal member 4 into the display area 3, and if the liquid crystal is about to flow out from the display area 3, the wall-like structure 5 enables the liquid crystal to flow outside the display area 3. Thus, the occurrence of a defective display due to the entrance of the seal member 4 melted by heating into the display area 3 can be prevented, and the liquid crystal injected can be made to prevail all over an area formed by the frame-shaped seal member 4.

[0024] In other words, the wall-like structure 5 is

constructed such that the occurrence of air traps in injecting the liquid crystal to be sealed can be prevented. For example, the wall-like structure 5 can be constructed to a row structure composed of a plurality of dashed rows.

[0025] A method of fabricating a liquid crystal display device according to the present invention comprises: a wall-like structure formation step for applying resin to a first substrate 1 and patterning the resin to form a wall-like structure 5 taking a frame shape, the wall-like structure 5 surrounding a display electrode 3; a seal member applying step for applying a seal member 4 of a frame shape to a portion of the first substrate outside the wall-like structure 5 formed in the wall-like structure forming step; an adhesion step for arranging a second substrate 2 so as to face the first substrate 1 applied with the seal member 4 in the seal member applying step, pressing the second substrate 2 against the first substrate 1, so as to adhere the first and second substrates 1 and 2 to each other by the seal member 4; and a liquid crystal injecting step for injecting a liquid crystal between the first and second substrates 1 and 2.

[0026] Here, the first substrate 1 in the present invention may be an array substrate on which a thin film transistor and the like are formed, or alternatively the first substrate 1 may be a CF substrate on which a colour filter and the like are formed.

[0027] In the wall-like structure formation step, if a column-like structure 6 for regulating the size of a gap between the first and second substrates 1 and 2 is formed by patterning together with the wall-like structure 5, a separate column-like structure formation step need not be provided. Particularly, in the case where the shape of the wall-like structure 5 is determined based on the position of the column-like structure 6 instead of a spacer, the wall-like structure 5 and the column-like structure 6 can be simultaneously formed, thus improving the quality of the manufactured product.

[0028] Furthermore, if the wall-like structure 5 formed in the wall-like structure formation step is constituted by dashed rows having predetermined notches and constituted by a frame-like structure composed of a plurality of rows, the seal member 4 melted in the adhesion step is prevented from flowing out to the display area 3.

[0029] On the other hand, if in the wall-like structure forming step, photosensitive resin is applied to the first substrate 1, and if a UV exposure is performed for the resin using a photomask, followed by curing the resin, it is then possible to form the wall-like structure by patterning with a high precision.

[0030] Furthermore, if the method of fabricating a liquid crystal display device of the present invention further comprises an alignment film applying step for applying an alignment film, which is performed after the wall-like structure formation step and the seal member applying step for applying a seal member, which is formed after the alignment film applying step, the align-

ment film is formed after a resist step performed at the time the wall-like structure 5 is formed. Thus, the disorderedness of the alignment due to the resist step can be preferably prevented.

[0031] Fig. 2 is a perspective view of the structure of a liquid crystal display device in a more detailed embodiment of the present invention. Reference numeral 21 denotes an array substrate that is a first substrate, and a thin film transistor (TFT), a display electrode, an alignment film and the like are formed on the array substrate 21. In this embodiment, in view of miniaturisation of the device, the device is designed such that the width of a narrow frame formed between the periphery of the array substrate 21 and the display area 30 is as narrow as 3 mm or less. On the other hand, reference numeral 22 denotes a CF substrate that is a second substrate, and a black matrix, a colour filter, an opposite electrode made of ITO and an alignment film are formed on the rear surface of the CF substrate 22. Moreover, at the periphery of the array substrate 21, a frame-shaped seal member 23 is formed so as to surround the display area 30 of the array substrate 21. In Fig. 2, the seal member 23 is provided on the array substrate 21. However, the seal member 23 may alternatively be provided on the CF substrate 22. Furthermore, in this embodiment, thermosetting resin made of epoxy resin containing hardening agent is used as the seal member 23. The CF substrate 22 is superposed on the array substrate 21, and pressed to each other, followed by heating both substrates. Thus, the seal member 23 is once gelatinised and then cured, whereby the array substrate 21 and the CF substrate 22 are firmly adhered to each other. Moreover, a liquid crystal injection port 24 is provided in the seal member 23. After the array substrate 21 and the CF substrate 22 are firmly adhered to each other, a liquid crystal is injected to a gap between the array substrate 21 and the CF substrate 22 from the liquid crystal injection port 24. Then, the liquid crystal injection port 24 is sealed by sealing agent (not shown) made of high purity silicone agent or the like.

[0032] Fig. 3 is a partially enlarged explanatory view showing the array substrate 21 and constituent components provided on the array substrate 21 in this embodiment of the present invention. Although the same constituent components may be provided on the CF substrate 22, these constituent components are provided on the array substrate 21 in this embodiment.

[0033] As described above, the seal member 23 is provided on the peripheral portion of the array substrate 21, and a display area 30 having a TFT array 31 and a display electrode 32 is provided inside the seal member 23. An image is actually displayed by the display area 30. Reference numeral 28 is a column member, which is used, instead of a spacer, to regulate a cell gap that is a distance (gap) between the array substrate 21 and the CF substrate 22. The proper number of column members 28 are formed on the array substrate 21 by patterning corresponding to, for example, positions of black

matrixes. Moreover, reference numeral 29 denotes an electrode (wiring) provided on the array substrate 21.

[0034] In this embodiment, a wall member 25 is provided between the seal member 23 and the display area 30. The wall member 25 is composed of two rows, each of which includes outer wall members 26 and inner wall members 27. The wall member 25 is made of ultraviolet-curing resin which is the same as that of the column member 28. The ultraviolet-curing resin is made of acrylic resin of 15 to 25 %, acrylic monomer of 10 to 20 %, photosensitive agent of 1 to 10 % and solvent of 55 to 65 %. The interval between the rows of the wall member 25 is set to 5 to 300 μm , and the rows take the shape of a dashed line having notches. Moreover, the notches of the row are alternately formed so as not to exist on a line perpendicular to the rows. In other words, the notches of one row constituted by either the outer wall member 26 or the inner wall member 27 are formed so as to face any of the wall members on the opposite row. In this embodiment, as concrete dimensions, a length (d1) of the wall member 25 is set to 100 μm to 100 mm, a length (s1) of the notch is set to 5 μm to 10 mm, a width (d2) of the outer wall member 26 is set to 5 μm to 50 μm , and a width (d3) of the inner wall member 27 is set to 5 μm to 50 μm . Moreover, a distance (s3) between the display area 30 and the inner wall member 27 is set to about 95 μm , and a gap (s2) between the outer wall member 26 and the inner wall member 27 is set to 5 μm to 300 μm . The outer wall member 26 and the inner wall member 27 arranged in two rows do not necessarily take the same shape, and the shapes of them are properly determined depending on the position of wiring members 29 and the position of a column member 28.

[0035] The reasons why the widths d2 and d3 of the outer and inner wall members 26 and 27 are set to 5 μm or more are as follows. Specifically, the outer and inner wall members 26 and 27 cannot be patterned to the widths of 5 μm or less, or they cannot be patterned precisely though the patterning is possible. On the other hand, the reason why the widths of the widths d2 and d3 of the outer and inner wall members 26 and 27 are set to 50 μm or less is as follows. Specifically, if the widths d2 and d3 are larger than 50 μm , an area ratio of the wall member 25 to the column member 28 provided in the display area 30 becomes large, and hence the gap between the array substrate 21 and the CF substrate 22 in the periphery portion, in which the wall member 25 is provided, becomes large, thus causing troubles such as a degradation of an image quality.

[0036] On the other hand, the reason why the length d1 of the wall member 25 is set to 100 μm or more is that it is difficult to prevent the seal member 23 from entering into the display area 30. The reason why the length d1 of the wall member 25 is set to 100 mm or less is that an area where the liquid crystal is not injected may be produced if the length d1 is larger than 100 mm. Moreover, the reason why the length (s1) of

the notch in each row is set to 5 μm to 10 mm is as follows. Specifically, if the length (s1) of the notch is shorter than 5 μm , the notch cannot be formed precisely and air traps where the liquid crystal is not injected are produced. If the length (s1) of the notch is longer than 10 mm, the effect obtained by arranging the wall member 25 in the two rows cannot be obtained.

[0037] Moreover, the reason why the gap (s2) between the outer wall member 26 and the inner wall member 27 is set to 5 μm to 300 μm is as follows. Specifically, if the gap (s2) is less than 5 μm , it is difficult to form the gap precisely, and the liquid crystal cannot be sometimes injected to the display area 30. If the gap (s2) is more than 300 μm , it is impossible to cope with the narrow frame design.

[0038] Figs. 4(a) and 4(b) show partial section views of the liquid crystal display device of this embodiment. Here, in the liquid crystal display device shown in Fig. 4(a), the outer wall member 26 and the inner wall member 27 constituting the wall member 25 are provided on the array substrate 21. Fig. 4(b) shows a modification of the liquid crystal display device, in which the outer wall member 26 and the inner wall member 27 constituting the wall member 25 are provided on the CF substrate 22.

[0039] In Fig. 4(a), the outer wall member 26 and the inner wall member 27 are formed by the same patterning processing for the column member 28. In this embodiment, the height of the outer and inner wall members 26 and 27 is set to about 4.5 μm . A colouring layer 36 is formed on the opposite CF substrate 22, and a facing-to-column member 35 is stacked on the colouring layer 36 by patterning. The column member 28 and the facing-to-column member 35 serve to keep the cell gap h1 at about 4.8 μm , which is a gap formed by the array substrate 21 and the CF substrate 22. As a result, the array substrate 21 and the CF substrate 22 are joined in a state that the outer wall member 26 and the inner wall member 27 create a gap of about 0.3 μm between the tops of the members 26 and 27 and the opposite substrate (electrode).

[0040] On the other hand, compared to Fig. 4 (a), the wall member 25 and the column member 28 may be formed on the CF substrate 22 side by patterning, and the facing-to-column member 35 may be stacked on the array substrate 21 side, as shown in Fig. 4(b). Particularly, as shown in Fig. 4(a), if the wall member 25 and the column member 28 having a large height are provided on the array substrate 21 side, the heights of the wall member 25 and the column member 28 are disturbed by other film formation steps, while the high projections apply the large impact on other steps. For this reason, it will be effective to provide the wall member 25 and the column member 28 having the high height on the CF substrate 22 side, not on the array substrate 21 side, in which complicated film formation steps are performed.

[0041] Fig. 5 shows an explanatory view showing a

situation that after formation of the seal member 23 the array substrate 21 and the CF substrate 22 are actually superposed, and pressed to each other while heating them.

[0042] By the pressing and heating treatment, the seal member 23 is gelatinised and flows out, as shown in Fig. 5. Since mixed resin is used for the seal member 23, a flowing-out speed of the seal member 23 is different due to a difference of material, and the spread is not straight. As a result, the melted seal member 23 tends to flow out while producing a meander line. In this embodiment, paying attention to the difference in the viscosities of the liquid crystal of a viscosity of 1 Pa s or less, which is injected later, the seal member 23 of a viscosity of 10 to 100 Pa s and a seal member (not shown) of a viscosity of 10 to 500 Pa s, the liquid crystal display device is constructed such that although the liquid crystal can enter the display area 30 without being obstructed by the outer and inner wall members 26 and 27 of the wall member 25, the seal member 23 does not enter the display area 30 by being obstructed by the wall member 25. Specifically, as shown in Fig. 5, the gelatinised seal member 23 collides with the outer wall member 26, and, by capillary phenomenon, spreads through the gap between the outer wall member 26 and one of the substrate 21 and the colouring layer 36, that is, the gap (h1 - 2) shown in Figs. 4(a) and 4(b). Then, the seal member 23 reaches the inner wall member 27. However, the entry of the seal member 23 into the display area 30 is stopped by the inner wall member 27, and the seal member 23 can be prevented from entering directly the display area 30.

[0043] On the other hand, since the liquid crystal to be injected into the cell gap afterward shows a low viscosity, the entry of the liquid crystal into the display area 30 is never obstructed by the outer and inner wall members 26 and 27 constituting the wall member 25. In other words, the wall member 25 has no influence on the injection of the liquid crystal into the cell gap sealed by the seal member 23. That is, the liquid crystal is sufficiently injected into the cell gap without producing any air traps. Particularly, since the wall member 25 forms the dashed line having the notches, the liquid crystal can enter the back side of the wall member 25, and can prevent the occurrence of the air traps.

[0044] As described above, according to the structure of the wall member 25 in this embodiment, since the seal member 23 showing a high viscosity can spread through the gap between the wall member 25 and the opposite substrate by capillary phenomenon, the seal member 23 never enters the display area 23 directly, and it is possible to prevent the disorderliness of the alignment due to the entrance of the seal member 23. On the other hand, with respect to the seal member 23 showing a low viscosity, the liquid crystal can flow into a sealed area formed by this seal member 23. As a result, the occurrence of air traps to be formed in an area where no liquid crystal flows into can be prevented,

thus preventing a defective display owing to the protrusion of the air trap of the liquid crystal into the display area 30.

[0045] Furthermore, in this embodiment, the width and length of the wall member 25 and the length of the notch of the wall member 25 are determined, based on the position of the column member 28, so that a ratio of an area of the wall member 25 to the opposite substrate and that of the column member 28 to the opposite substrate are equal to each other. This makes it possible to keep substantially constant the cell gap that is a gap formed by the array substrate 21 and the CF substrate 22, thus preventing the occurrence of trouble which causes a defective display owing to a large gap between these substrates in the periphery portion where the wall member 25 is formed.

[0046] Figs. 6(a) to 6(e) show a method of fabricating the liquid crystal display device in this embodiment. It should be noted that in Figs. 6(a) and 6(e), although an example is described in which the wall member 25 and the column member 28 are formed on the array substrate 21, the wall member 25 and the column member 28 can be formed on the CF substrate 22 as described above.

[0047] First, Fig. 6(a) shows a resist applying step. In the applying step, ultraviolet-curing resin 40 made of photosensitive acrylic resin is applied (resist coating) onto the array substrate 21 made of a glass substrate to a thickness of about 5 μm . Polyimide resin is used instead of the acrylic resin depending on the structure of the CF substrate 22.

[0048] Next, the procedure advances to a patterning step for forming the wall member 25 and the column member 28 shown in Fig. 6(b). In this patterning step, a UV exposure is first performed using a photomask. A negative formed by the UV exposure can be obtained. That is, the portions of the photosensitive ultraviolet-curing resin 40 radiated by a light are cured, thus obtaining the basic structures of the wall member 25 and the column member 28. As a matter of course, in the UV exposure, the basic structures of them can be also obtained by a positive. Thereafter, an alkali developing is performed to remove uncured portions, and the array substrate 21 is washed out and dried. The cured resin is baked at a temperature of about 230 $^{\circ}\text{C}$. The resin forming the wall member 25 and the column member 28 are fully hardened by this baking. After the wall member 25 and the column member are formed, a polyimide alignment film is applied. The reason why the step for applying the alignment film is performed after the formation of the wall member 15 and the column member 28 is that the execution of the resist step after applying the alignment film disorders the alignment.

[0049] Subsequently, the procedure advances to a step for applying the seal member 23 shown in Fig. 6(c). In this embodiment, the seal member 23 using thermosetting resin made of epoxy resin is formed to a frame-like shape outside the wall member 26 formed in the

step shown in Fig. 6(b). The seal member 23 is applied using a dispenser method in a state that the seal member 23 has a somewhat high height for the necessary cell gap. At this time, a liquid injection port for injecting the liquid crystal later is provided.

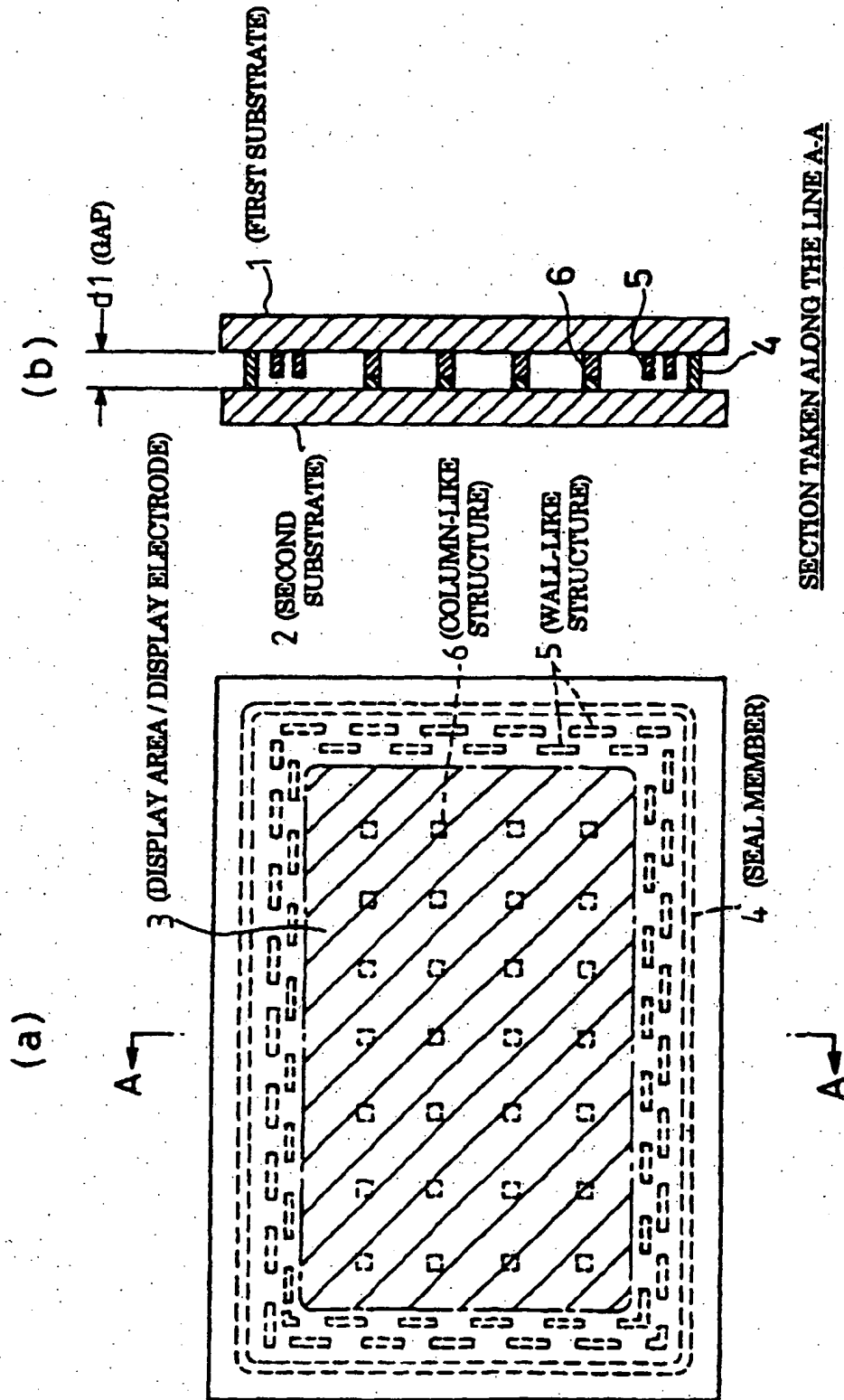
[0050] Next, the procedure advances to an assembly step shown in Fig. 6(d). In this step, the CF substrate 22 that is an opposite substrate on which the alignment film is pressed against the array substrate 21 on which the wall member 25, the column member 28 and the seal member 23 are formed, thus firmly adhering them to each other. To be more specific, after the CF substrate 22 is superposed on the array substrate 21, if the size of the substrates are 360 mm - 460 mm, a pressure of a little less than 1 ton is applied and heated at a temperature of about 150 $^{\circ}\text{C}$. The seal member 23 melts by heating and is gelatinised. Thereafter, the seal member 23 becomes cured resin from fluid resin by a curing reaction of curing agent contained therein. Thus, the seal member 23 is firmly adhered to the CF substrate 22, and the array substrate 21 and the CF substrate 22 are joined to each other in a state that the cell gap, which is the gap decided by the column member 28 and the foregoing facing-to-column member 35, is kept. In the embodiment, when the array substrate 21 and the CF substrate 22 are joined, the gelatinised seal member 23 enters the gap formed between the wall member 25 and the opposite substrate (CF substrate 22) by the capillary phenomenon. Thus, the gelatinised seal member 23 never reaches the display area 30 composed of a display electrode and the like, and the remains at the position of the wall member 25 to harden there.

[0051] Finally, the procedure advances to a liquid crystal injection step shown in Fig. 6(e). A sealed area by the seal member 23 is evacuated, and the liquid crystal is injected from the liquid crystal injection port 24. Since the injected liquid crystal has a very low viscosity, regardless of the wall member 25 the liquid crystal reaches the display area 30 beyond the wall member 25. As a result, it is possible to perform the injection of the liquid crystal without producing the air traps. Thereafter, the liquid crystal injection port 24 is stopped by a seal member, thus finishing a series of fabrication steps.

[0052] According to the method of fabricating a liquid crystal display device in this embodiment, the array substrate 21 and the CF substrate 22 can be joined by the seal member 23 while keeping the cell gap between the both substrates constant all over the both substrates. The occurrence of the air traps in injecting the liquid crystal can be prevented, so that it will be possible to fabricate a high reliability liquid crystal display device. Moreover, the wall member 25 which inhibits the entry of the seal member 23 to the display area 30 is patterned simultaneously with the column member 28, so that an especial step for forming the wall member 25 needs not to be performed.

Claims

1. A liquid crystal display device which has a first substrate (1, 21) and a second substrate (2, 22) disposed with a predetermined gap between them; 5
 - a seal member (4, 23) provided in said gap between said first and second substrates, said seal member being disposed outside a display area (3) to seal a liquid crystal material in said gap; and 10
 - a barrier structure (5, 25) disposed outside said display area and inside said seal member, said barrier structure being effective to prevent said seal member from flowing into said display area without preventing flow of said liquid crystal material. 15
2. A liquid crystal display device as claimed in claim 1 20
 - in which said barrier comprises multiple walls made of a different material from that of said seal member.
3. The liquid crystal device according to claim 2, 25
 - wherein each of said multiple walls is composed of alternate wall portions and notches.
4. The liquid crystal device according to claim 1, 30
 - wherein said multiple walls are staggered relative to each other so that said seal material cannot flow directly into said display area, through said notches.
5. The liquid crystal display device according to any 35
 - one of claims 2 to 4, wherein a column-like structure for maintaining the gap between said first and second substrates constant is provided.
6. The liquid crystal device according to any one of 40
 - claims 3, 4 and 5 wherein positions of the notches of the plural dashed rows in said walls are determined based on the position of wiring formed either on said first substrate or on said second substrate.
7. The liquid crystal device according to any one of 45
 - claims 2 to 6, wherein said walls are of a height lower than that of the gap formed between said first substrate and said second substrate.
8. The liquid crystal display device according to any 50
 - preceding claim, wherein flow of said seal member occurs during manufacture when said second substrate is pressed into said first substrate while heating said first and second substrates.
9. The liquid crystal display device according to claim 55
 - 8, wherein said barrier structure prevents air traps
- from occurring when said liquid crystal to be sealed flows into said display area.
10. A method of fabricating a liquid crystal display device, comprising the steps of:
 - applying resin onto a first substrate, and patterning said resin to form a frame-shaped barrier structure surrounding a display electrode area;
 - applying a frame-shaped seal member outside said barrier structure;
 - arranging a second substrate so as to face said first substrate on which said seal member is applied, and pressing said second substrate to said first substrate, thereby adhering said first and second substrates to each other by said seal material; and
 - injecting a liquid crystal material into a gap between said first and second substrates, which are adhered to each other, said barrier being formed so as to prevent flow of said seal material into said display electrode area without preventing flow of said liquid crystal material during said injection step.
11. The method according to claim 10, wherein a column-like structure for regulating size of the gap between said first and second substrates is formed together with said barrier structure by patterning.
12. The method according to any one of claims 10 and 11, wherein said barrier structure is formed as multiple walls each comprising alternate wall portions separated by notches.
13. The method according to any one of claims 10, 11 and 12, wherein said barrier structure is formed by applying photosensitive resin onto said first substrate, performing a UV exposure for the resin using a photomask, and curing the resin.
14. The method according to any one of claims 10, 11, 12 and 13, wherein an alignment film is applied after the formation of said barrier structure, and then said seal member is applied outside said barrier structure.



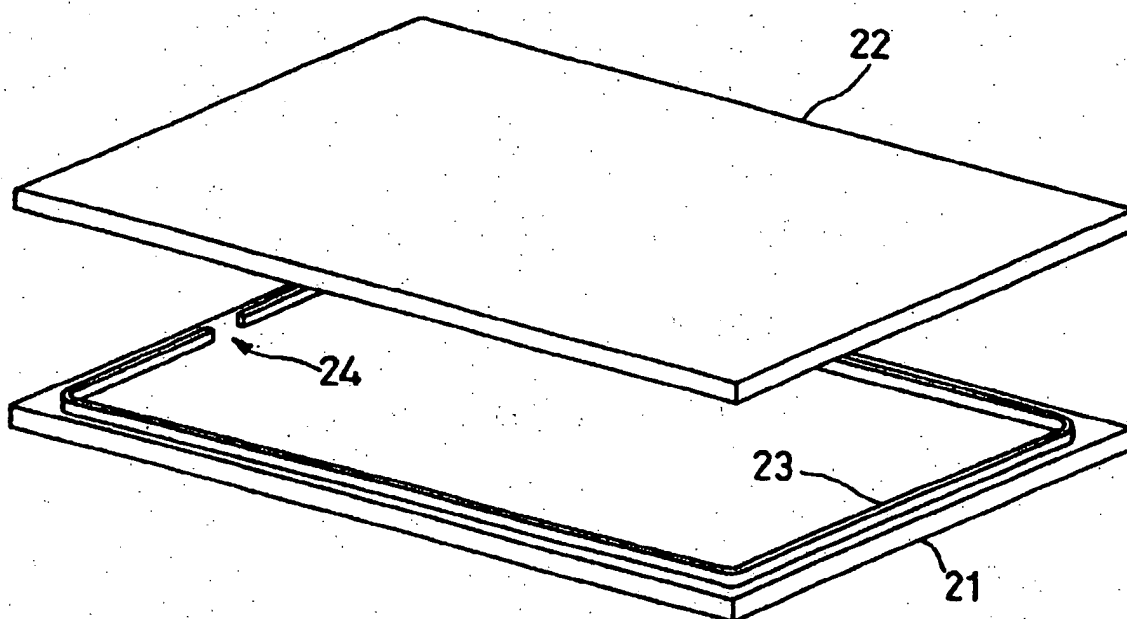


FIG. 2

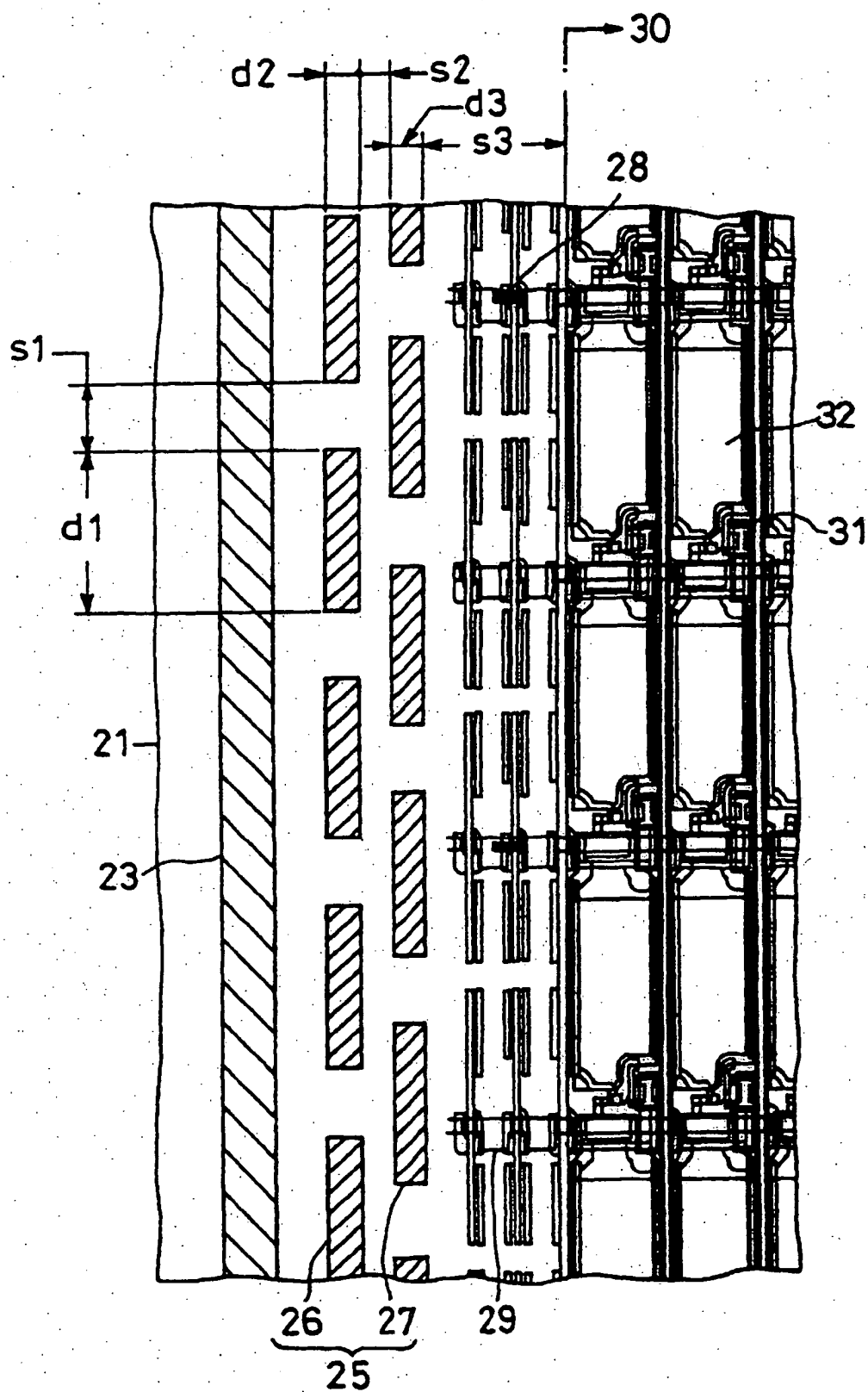


FIG. 3

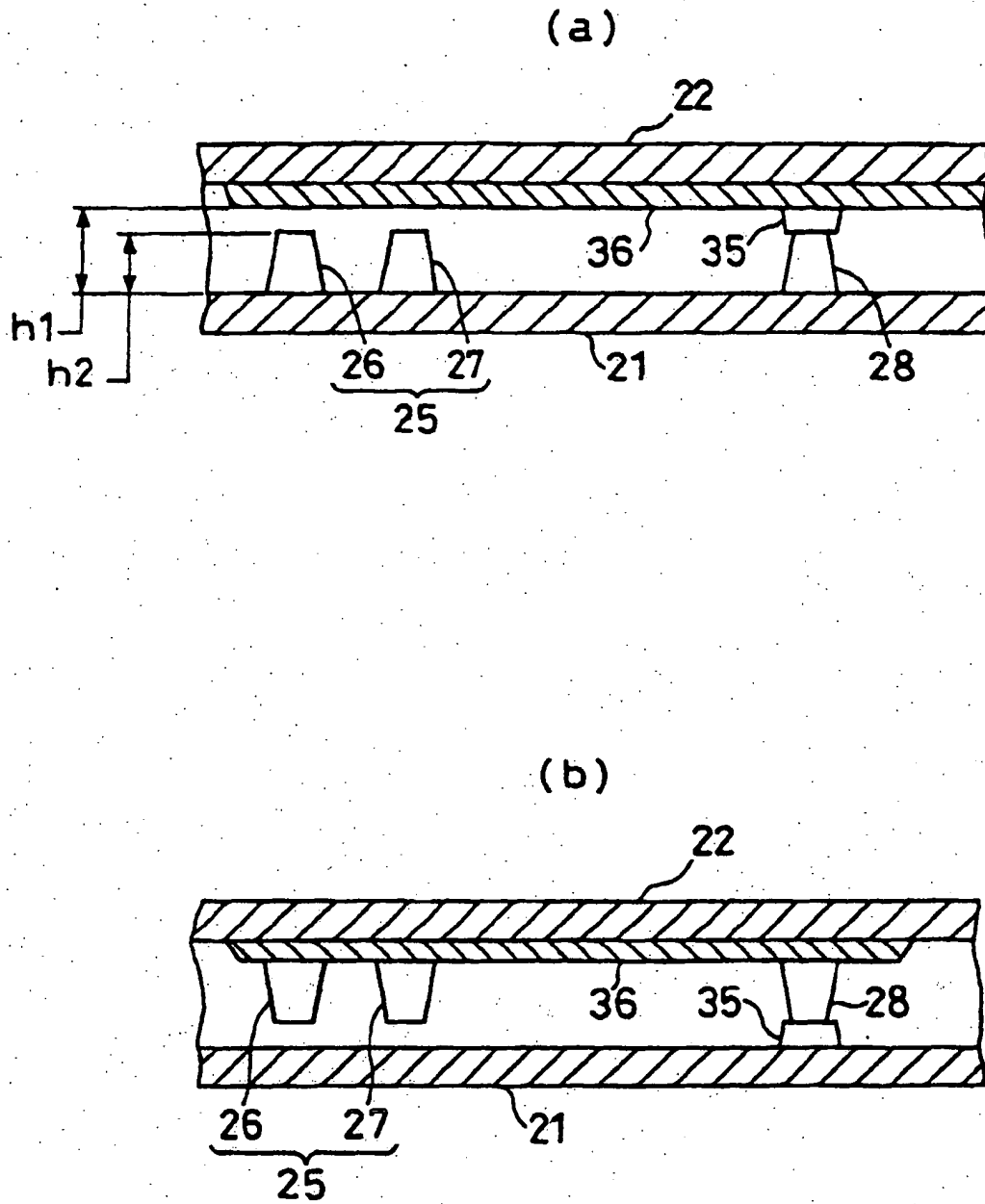


FIG. 4

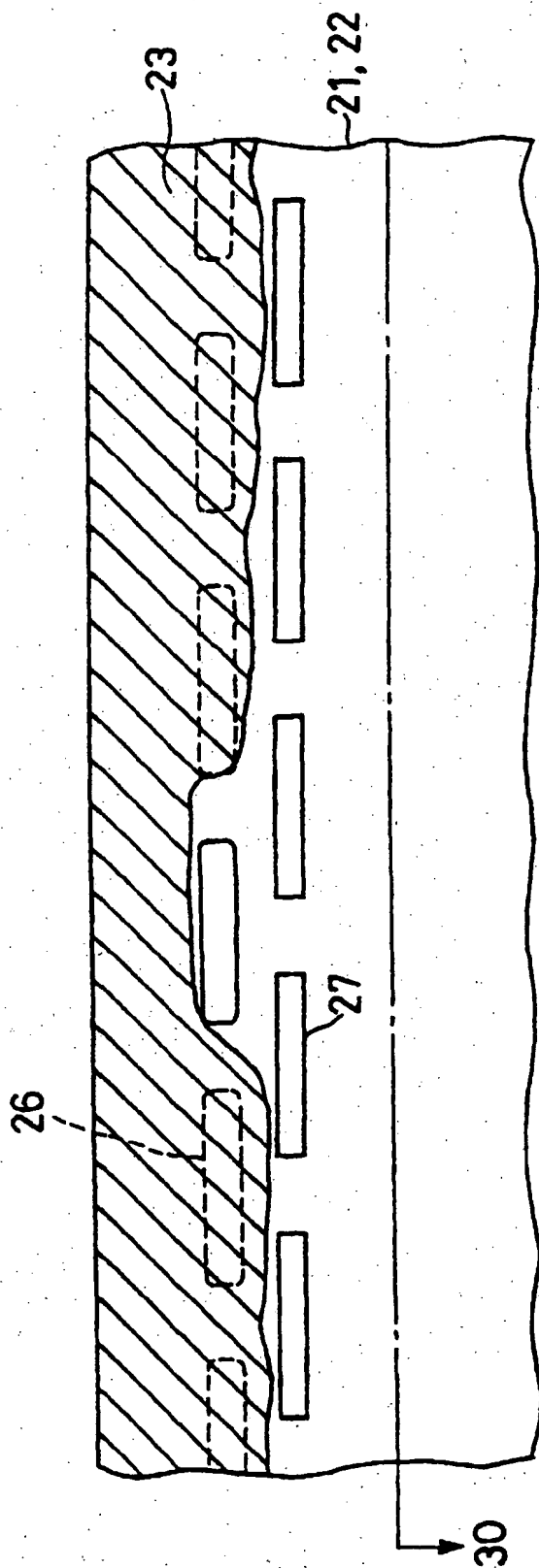


FIG. 5

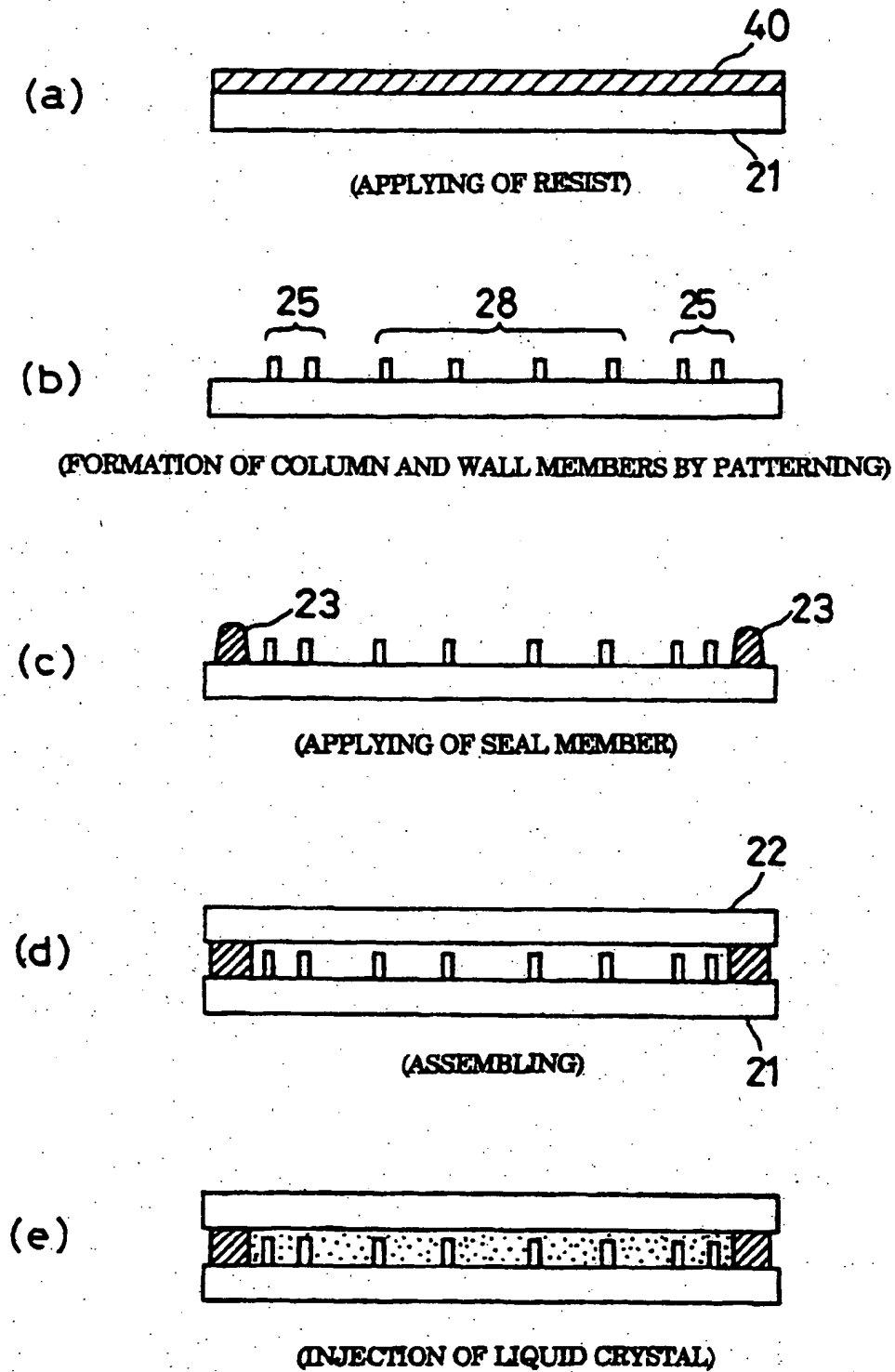


FIG. 6

(19)



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(54) Liquid crystal display device and method of fabricating the same

(57) A liquid crystal display device comprises first and second substrates 1 and 2 disposed at a predetermined gap d1; a liquid crystal sealed in the gap d1; a seal member 4 provided at the gap d1 between the first and second substrates 1 and 2 and outside a display area 3, the seal member 4 being for sealing the liquid

crystal; and a wall-like structure 5 provided outside the display area 3 and inside the seal member 4, the wall-like structure 5 being made of a material different from that of the seal member 4 and composed of a plurality of rows, effective to prevent flow of the seal material into the display area.

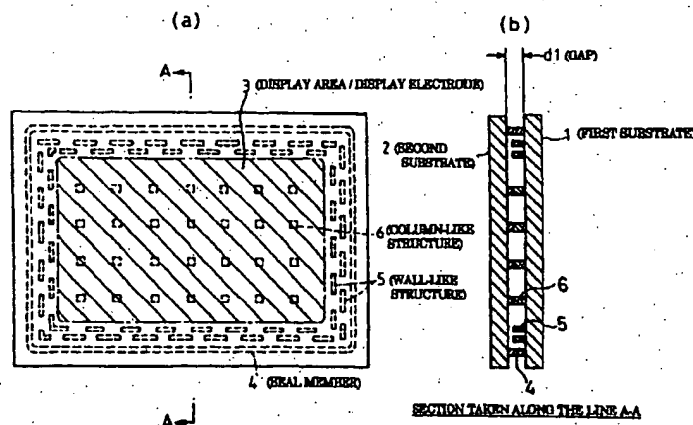


FIG. 1



European Patent
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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CI.7)
X	EP 0 740 186 A (IBM) 30 October 1996 (1996-10-30) * figures 1,2 *	1,3,4, 10,12,13	G02F1/1339
X	US 5 831 710 A (COLGAN EVAN G. ET AL) 3 November 1998 (1998-11-03) * figures 2,7 *	1,3-5, 10-13	
A	EP 0 113 064 A (TEKTRONIX INC) 11 July 1984 (1984-07-11) * figure 4 *	7	
			TECHNICAL FIELDS SEARCHED (Int.CI.7)
			602F
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 21 May 2001	Examiner G111, R
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21-05-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0740186 A	30-10-1996	JP 8297286 A	12-11-1996
		US 5777713 A	07-07-1998
		KR 242481 B	01-02-2000
US 5831710 A	03-11-1998	CN 1200493 A	02-12-1998
		JP 10221695 A	21-08-1998
EP 0113064 A	11-07-1984	JP 59116719 A	05-07-1984